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The Compact Muon Solenoid Experiment

CMS Note

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Muon DT Database requirements

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Abstract

Muon Drift Tubes issues for CMS Core DB Team are described here

1 The Muon DT System

Drift Tube Chambers (DTs) are used in the barrel of the Compact Muon Solenoid (CMS) detector at CERN; see Fig. 1. The DT system is made of four stations forming concentric cylinders around the beam line: three of them consist of 60 drift chambers each, 12 per wheel, the fourth, the most outer, of 70, 14 per wheel. Chambers are positioned in order to form 12 sectors in each wheel, with 1 chamber per station and sector; two sectors will have 2 chambers for the fourth station. Drift tubes are arranged in layers, with 4 layers grouped to build up a ”superlayer”; chambers in three stations are then made by assembling 3 such superlayers; two of them will be oriented with wires parallel to LHC beam, to measure Rphi coordinate, and one orthogonal to give Zed coordinate. Chambers in the outermost station are made of only 2 superlayers, with the ”Zed” SL missing. The whole system then contains 250 chambers and 680 superlayers; the total number of sensitive wires is about 175000.

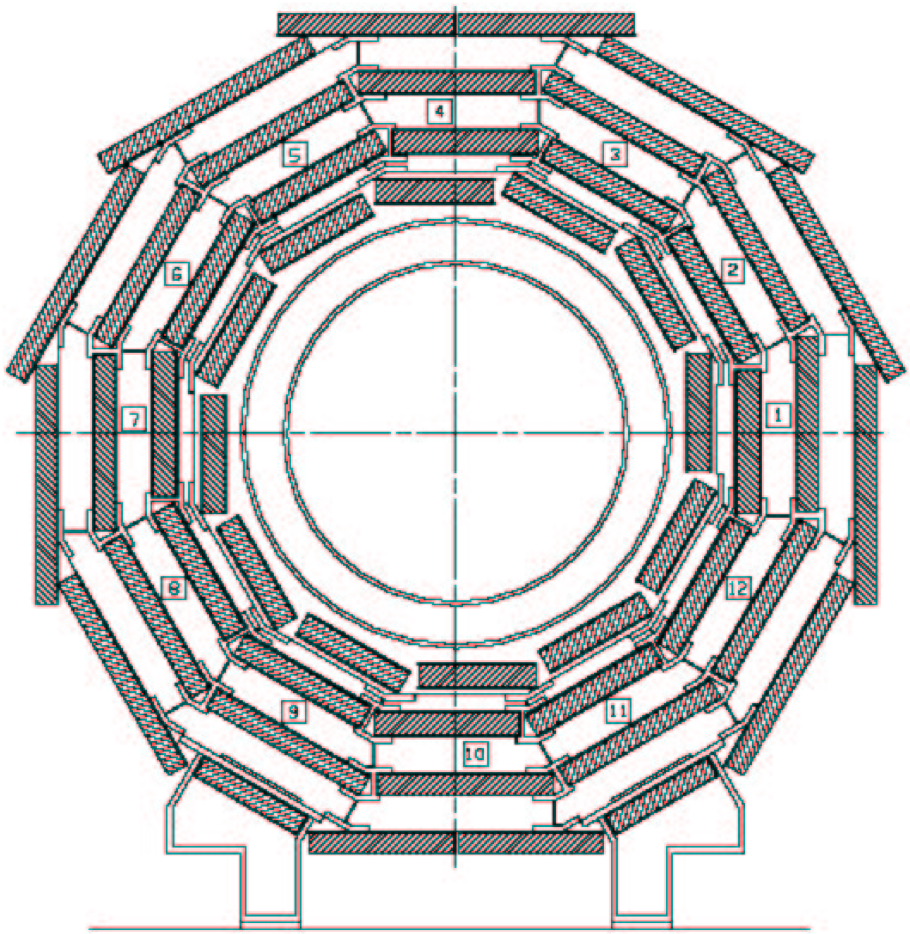

Figure 1: Layout of the CMS barrel muon DT chambers in one of the 5 wheels

Drift tubes are 42mm wide and 13mm high, and electrical field inside is provided by applying HV to wires and I-shaped cathodes defining cell width; drift lines are ”squeezed” by positively-biased strips placed at the center of the cell. Tubes are filled with Ar/CO_2 mixture; gas composition and HV are chosen to achieve for linear space-time relationship.

Front End circuitry is located in the opposite side enclosure of each SL from the HV distribution. A Front End Board will be connected to 20 wires, arranged in “columns” spanning the four layers.

Signals from the Front End will be taken to Read Out Boards (ROBs); each ROB will have four 32-channel TDC and will receive up to 128 signals from FE. Some special ROB for innermost station chambers will receive only 32 signals. After digitization, data are collected by one dedicated Read Out Server (ROS) per sector, linked to 25 ROBs; for sectors with an additional chamber at station 4 corresponding ROBs will be connected to spare links in other sectors. In each wheel 6 ROS will be connected to a DDU.

Trigger front-end devices are Bunch and Track Identifiers (BTI), connected with 9 tubes each, with overlaps allowing a tube to be connected to up to three BTIs; BTIs generate triggers and measure position and direction of trigger candidate segments. Data from BTIs connected to ”Phi” superlayers undergo further processing; Track Correlator (TRACO) devices are used to correlate segments of the ”inner” and ”outer” superlayer. TRACOs connect four BTIs of the inner superlayer to twelve of the outer superlayer, allowing for overlaps such that a BTI in the outer SL will be connected to three TRACOs. TRACOs and BTIs will be assembled in Trigger Boards (TRB) with 4 TRACOS and 32 BTIs; smaller TRBs with one TRACO and eight BTIs will be used for chambers in the inner cylinder.

High voltage will be provided by SY1527 supplies, serving 8 sectors each through an A876 module; each A876 will be connected to four A877, one per chamber. Cabling with chambers will use three connectors, one per superlayer, with 8 pins for wires, 4 pins for strips and 4 pins for cathodes; each channel will give voltage to wires in half a layer, or strips or cathodes in a full layer. Voltage will arrive to drift tubes through cards connected to 4, 8 or 9 cells in each of two adiacent layers; any channel will give voltage to several cards by mean of splitting.

Low voltage description

The system parts and their relations may be represented by mean of the “concept map” shown in fig.2 .

2 Numbering schema

All described objects may be identified by mean of numbers, following a “tree” schema where any object is identified by mean of its parent id. plus a number, in a hierarchical way inside each domain (detector, front-end, read-out, trigger, high voltage). The identifiers for each object are summarized in table 1 .

3 Database

Hardware objects, as well as their connections, are to be described by mean of tables with identifiers as primary keys; foreign keys will be used to find out relevant connections. Object identifiers will be used as foreign keys in tables containing conditions/calibration data.

Part of conditions data is made with information collected about detector status, such as temperatures, pressures, voltages. These quantities are expected to be measured at run start or repeatedly with some frequency (e.g. once per hour), and are summarized in table 2 .

Listed quantities may be studied to spot any problem in detector or for a survey of on-off channels, but they’re not expected to be used by reconstruction software.

In addition, other quantites are to be collected and stored to be used directly in the reconstruction process; these quantities are offsets (t0s) to be subtracted from times measured by TDCs, to account for delays due to cables, and electron drift velocity inside tubes. Corresponding data size are shown in table 3 .

T0s are to be measured by sending synchronous pulses to Front-End and collecting Read-out response; this may be done in time between LHC fills or in correspondence with empty bunch crossings in the orbit.

Drift velocity may be estimated by mean of the “Mean-Timer” technique exploiting layers half-cell staggering; the technique allows a determination of the maximum drift time corresponding to muons hitting the cell edge, at 21mm distance from the wire. Drift velocity is expected to be monitored on a Superlayer basis, extracting an average value from all the cell columns inside the superlayer itself. This quantity is also a parameter to set at configuration, being used by BTIs to identify bunch-cross for tracks hitting the detector.

Both t0s and drift velocity are expected to be quite stable during normal CMS operation, so their writing on database during fill time appears unnecessary; on the contrary a consequence of their use for reconstruction is an heavy access on the reading side.

Detector configuration will be performed by sending 256-byte character string commands to CCBs; the safest way to later retrieve detector status is simply storing on Condition DB the commands themselves, together with CCB response. Configuration is not foreseen to change during data taking, so this “configuration dump” is to be performed just at run start. Total size of configuration data is about 33 kBytes.

A special case is given by the possibility to set channel masks for Front-End and BTIs; in the occurrence of noise appearing on some channel corresponding mask setting is expected to be done without a need for run stop and start. On the other side, the mask table could be possibly read at reconstruction time, and a “software” mask table to cut away signals coming from bad channels.

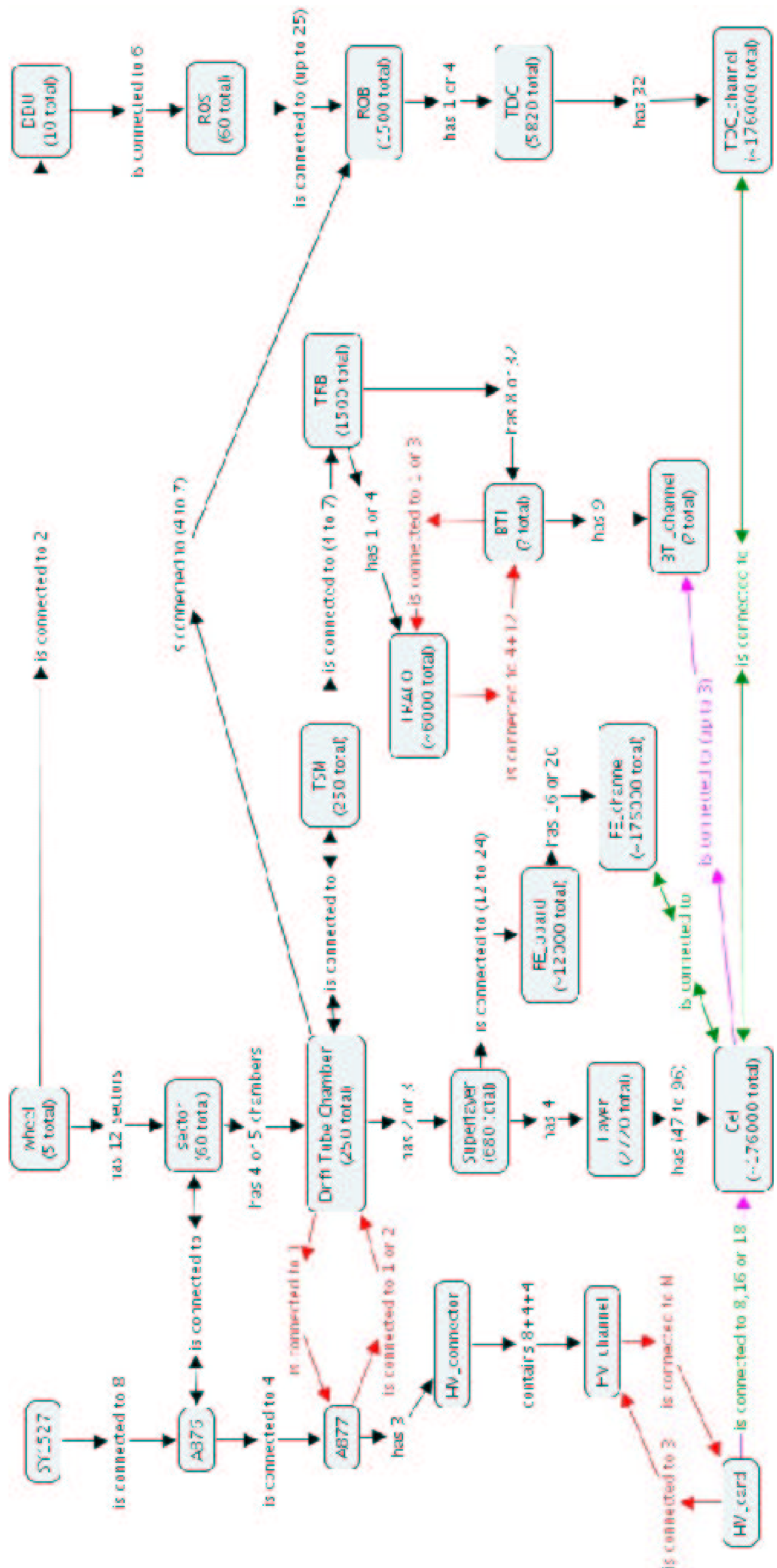

Figure 2: “Concept Map” for the Muon DT system

Detector:

OBJECT	IDENTIFIERS
Wheel	Wheel_ID (-2 to +2)
Station	Wheel_ID, Station_ID (1 to 4)
Chamber	Wheel_ID, Station_ID, Chamber_ID (1 to 14)
Superlayer	Wheel_ID, Station_ID, Chamber_ID, Superlayer_ID (1 to 3)
Layer	Wheel_ID, Station_ID, Chamber_ID, Superlayer_ID, Layer_ID (1 to 4)
Cell	Wheel_ID, Station_ID, Chamber_ID, Superlayer_ID, Layer_ID, Cell_ID (1 to 96)

Front-End:

OBJECT	IDENTIFIERS
Front End Board	Wheel_ID, Station_ID, Chamber_ID, Superlayer_ID, FEB_ID (1 to 24)
Front End Channel	Wheel_ID, Station_ID, Chamber_ID, Superlayer_ID, FEB_ID, Channel_ID (1 to 20)

Read-Out:

OBJECT	IDENTIFIERS
DDU	DDU_ID (1 to 10)
Read Out Server	DDU_ID, ROS_ID (1 to 6)
Read Out Board	DDU_ID, ROS_ID, ROB_ID (1 to 25)
TDC	DDU_ID, ROS_ID, ROB_ID, TDC_ID (1 to 4)
Tdc Channel	DDU_ID, ROS_ID, ROB_ID, TDC_ID, TDC_CHANNEL_ID (1 to 32)

Trigger:

OBJECT	IDENTIFIERS
Trigger Board	Wheel_ID, Station_ID, Chamber_ID, TRB_ID (1 to 7)
Track Correlator	Wheel_ID, Station_ID, Chamber_ID, TRB_ID, TRACO_ID (1 to 4)
BTI	Wheel_ID, Station_ID, Chamber_ID, TRB_ID, BTI_ID (1 to 32)
BTI Channel	Wheel_ID, Station_ID, Chamber_ID, TRB_ID, BTI_ID, BTI_CHANNEL_ID (1 to 9)

High Voltage:

OBJECT	IDENTIFIERS
SY 1527	SY1527_ID (1 to 8)
A876	SY1527_ID, A876_ID (1 to 8)
A877	SY1527_ID, A876_ID, A877_ID (1 to 4)
HV_Connector	SY1527_ID, A876_ID, A877_ID, HV_Connector_ID (1 to 2 or 3)
HV_Channel	SY1527_ID, A876_ID, A877_ID, HV_Connector_ID, HV_Channel_ID (16 codes)
HV_Card	Wheel_ID, Station_ID, Chamber_ID, Superlayer_ID, HV_Card_ID
HV_Card_Layer	Wheel_ID, Station_ID, Chamber_ID, Superlayer_ID, HV_Card_ID, Layer_Side (1 to 2)

Table 1: Numbering schema for objects in various domains for DT system

Object	Quantity	Size(bits)	Multiplicity	Total Size (kB)	Frequency
Front-End Board	Temperature	10	11000	14	at run start
Superlayer	Mean FEB Temp	10	680	1	once per hour
Trigger Board	Temperature	10	1500	2	once per hour
Chamber	Pressure	10	2*250	1	once per hour
Read-Out Board	Status	128	1500	24	once per hour
HV Channel	Voltage	16	10560	21	once per hour
HV Channel	Current	16	10560	21	once per hour
LV Channel	-	-	-	-	once per hour

Table 2: Measured quantities to monitor detector conditions

Object	Quantity	Size(bits)	Multiplicity	Total Size (kB)
Cell	t0	32	175000	680
Superlayer	Max Drift Time	32	680	3

Table 3: Calibration quantities to be read from reconstruction software

References

[1] **CMS Note 2005/000**, X.Somebody et al., *”CMS Note Template”*.